# Measurement of azimuthal correlations of D mesons with charged particles in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE at the LHC

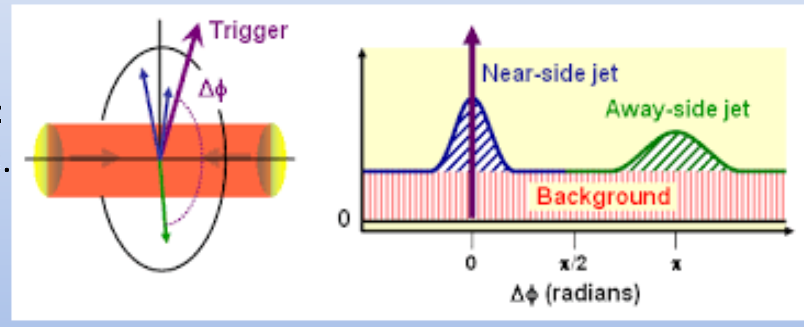

## Samrangy Sadhu on behalf of the ALICE collaboration

## Variable Energy Cyclotron Centre, Kolkata


## Introduction and Physics motivation

Due to their large masses, heavy quarks (charm and beauty) are produced in parton-parton hard scatterings in the early stages of ultra-relativistic heavy-ion collisions before the formation of Quark-Gluon Plasma (QGP). So, they **experience the full evolution of the medium**, interact with its constituents and lose energy via both collisional and radiative processes [1,2].

The study of angular correlations between heavy-flavour particles and charged particles in pp collisions allows us to:
- Characterize charm-quark jets and study their properties.
- Retrieve information on the different charm production mechanisms.
- Provide a reference for p-Pb and Pb-Pb collisions.




**Features of correlations using heavy-flavour particles:**
- "Trigger" particle defined by its identity and not by a $p_T$ threshold.
- Harder fragmentation of charm quark -> closer to parton kinematics.

## Experimental setup

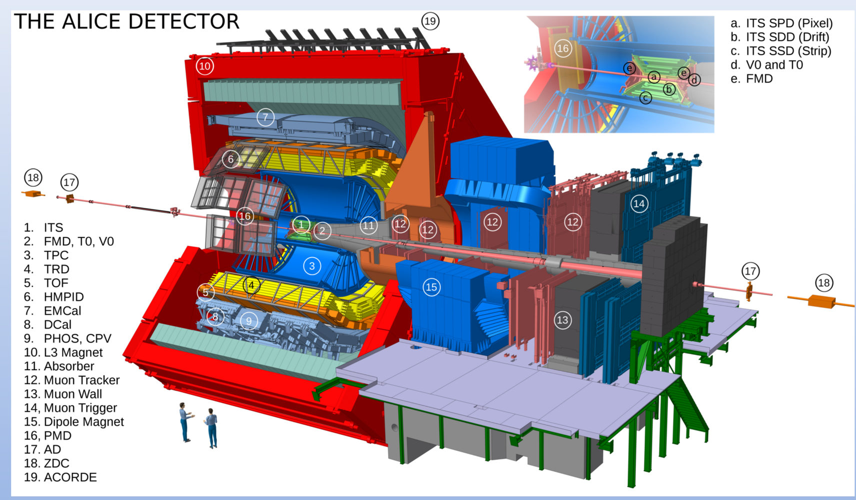
The ALICE detectors used in this analysis are:

**Inner Tracking System (ITS)**
- Vertex and track reconstruction

**Time Projection Chamber (TPC)**
- Track reconstruction and particle identification via d$E$/d$x$

**Time-of-Flight (TOF)**
- Particle identification

**V0 (scintillator array)**
- Event trigger

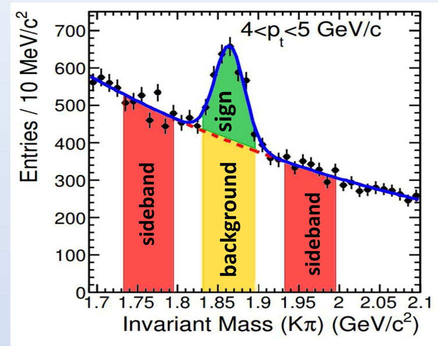



## Analysis strategy

- **D-meson signal extraction:**

  Reconstruction of D mesons ($D^0$, $D^+$, $D^{*+}$ and their charge conjugates) is done via their hadronic decay channels $D^0 \rightarrow K^-\pi^+$ (BR of 3.89±0.04%), $D^+ \rightarrow K^-\pi^+\pi^+$(BR of 8.98±0.28%), $D^{*+} \rightarrow D^0\pi^+$ (BR of 67.7±0.5%)

  The selection of D-meson candidates is based on the reconstruction of displaced secondary vertices and particle identification on the daughter tracks [3].




- **Azimuthal correlations:**
  - ✦Each D-meson (both signal and background) is correlated with all charged particles of the same event.
  - ✦The correlations are built in different D meson $p_T$ intervals, i.e. 3-5, 5-8, 8-16 GeV/$c$.

- **Background subtraction and corrections:**
  - ✦The $(\Delta\eta, \Delta\varphi)$ azimuthal correlation distribution in the sideband region is used to subtract the correlations from D-meson combinatorial background.
  - ✦The correlation distributions are corrected for limited detector acceptance and spatial inhomogeneities using **mixed event technique**.
  - ✦The correlation distributions are corrected for trigger and associated track efficiencies.
  - ✦Correlation distributions are normalized by the number of D-meson triggers and corrected for the contamination of secondary particles in the charged-particle sample.
  - ✦The contribution of D mesons originated from B-hadron decays is removed through a feed-down correction [3].

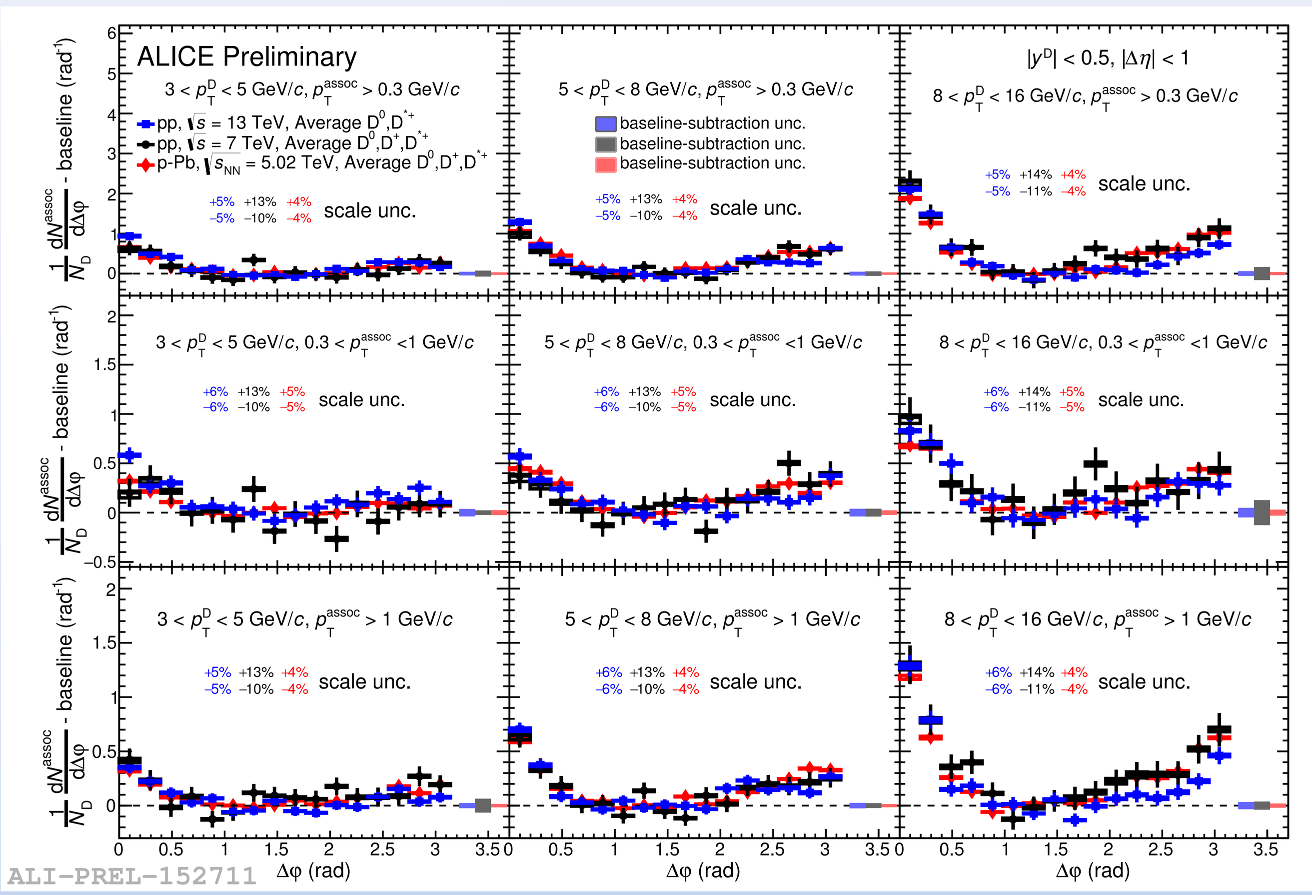
- **Averaging and fitting:**
  - ✦Projection of $(\Delta\eta, \Delta\varphi)$ correlation distribution along $\Delta\varphi$ axis to reduce statistical fluctuations .
  - ✦Weighted average of $D^0$, $D^+$, $D^{*+}$ distributions.
  - ✦Fitting of fully-corrected correlation distributions with two Gaussian functions (describing near-side and away-side peaks) and a constant term for baseline.
  - ✦Extraction of physical observables (peak yields, widths and baseline heights) from these fits.

## Results

### Comparison of $\Delta\varphi$ distribution in pp and p-Pb collisions

pp, $\sqrt{s}$ = 13 TeV
pp, $\sqrt{s}$ = 7 TeV
p-Pb, $\sqrt{s_{NN}}$ = 5.02 TeV

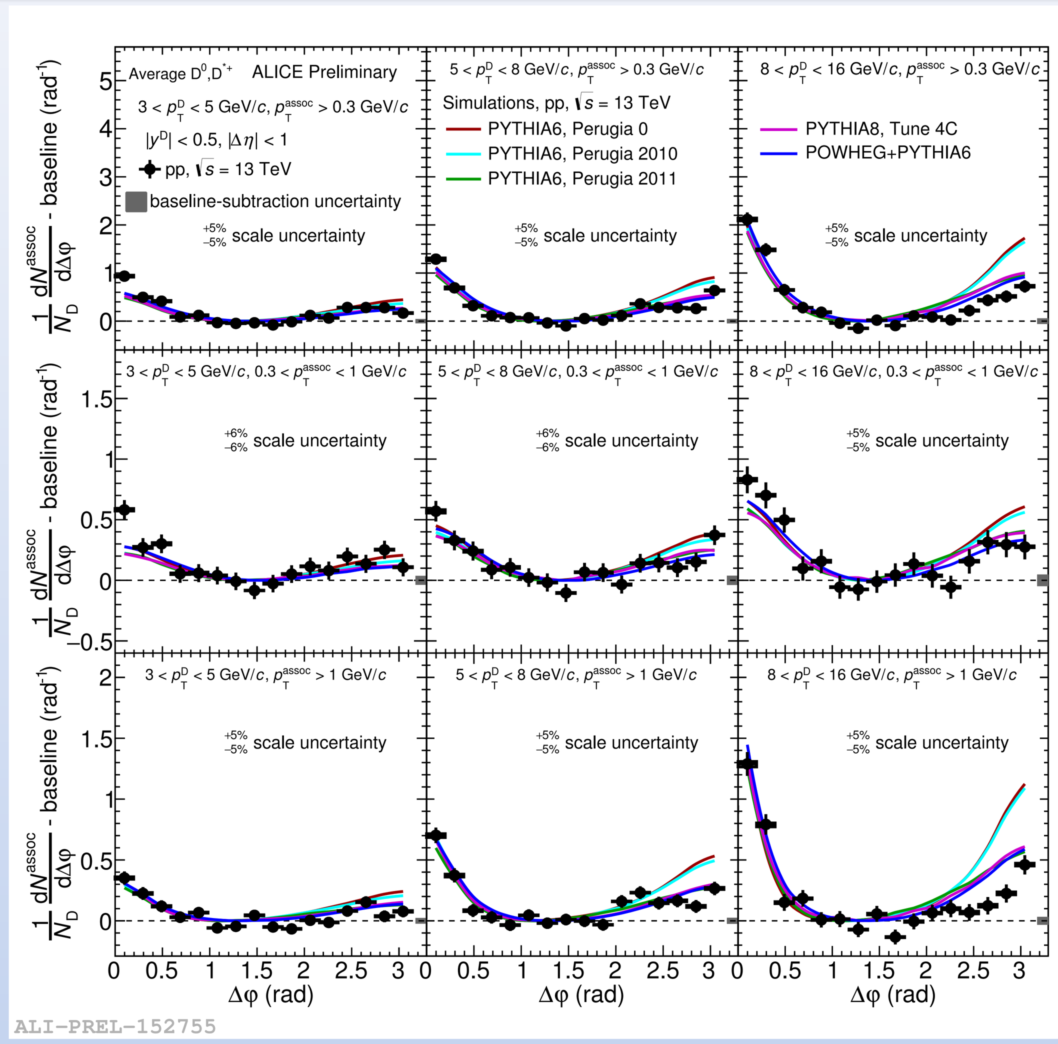
- Average of the results from three D-mesons species ($D^0$ and $D^{*+}$ only for pp $\sqrt{s}$ = 13 TeV), weighted with statistical and uncorrelated systematic uncertainties.
- The comparison of the results is performed after subtraction of the baseline.
- Compatibility within uncertainty is found for all the kinematic ranges.




### Comparison of $\Delta\varphi$ distribution with Monte Carlo predictions

pp $\sqrt{s}$ = 13 TeV
Comparison with:
PYTHIA6 tunes Perugia 0, Perugia 2010, Perugia 2011
PYTHIA8
POWHEG+PYTHIA6 [4,5]

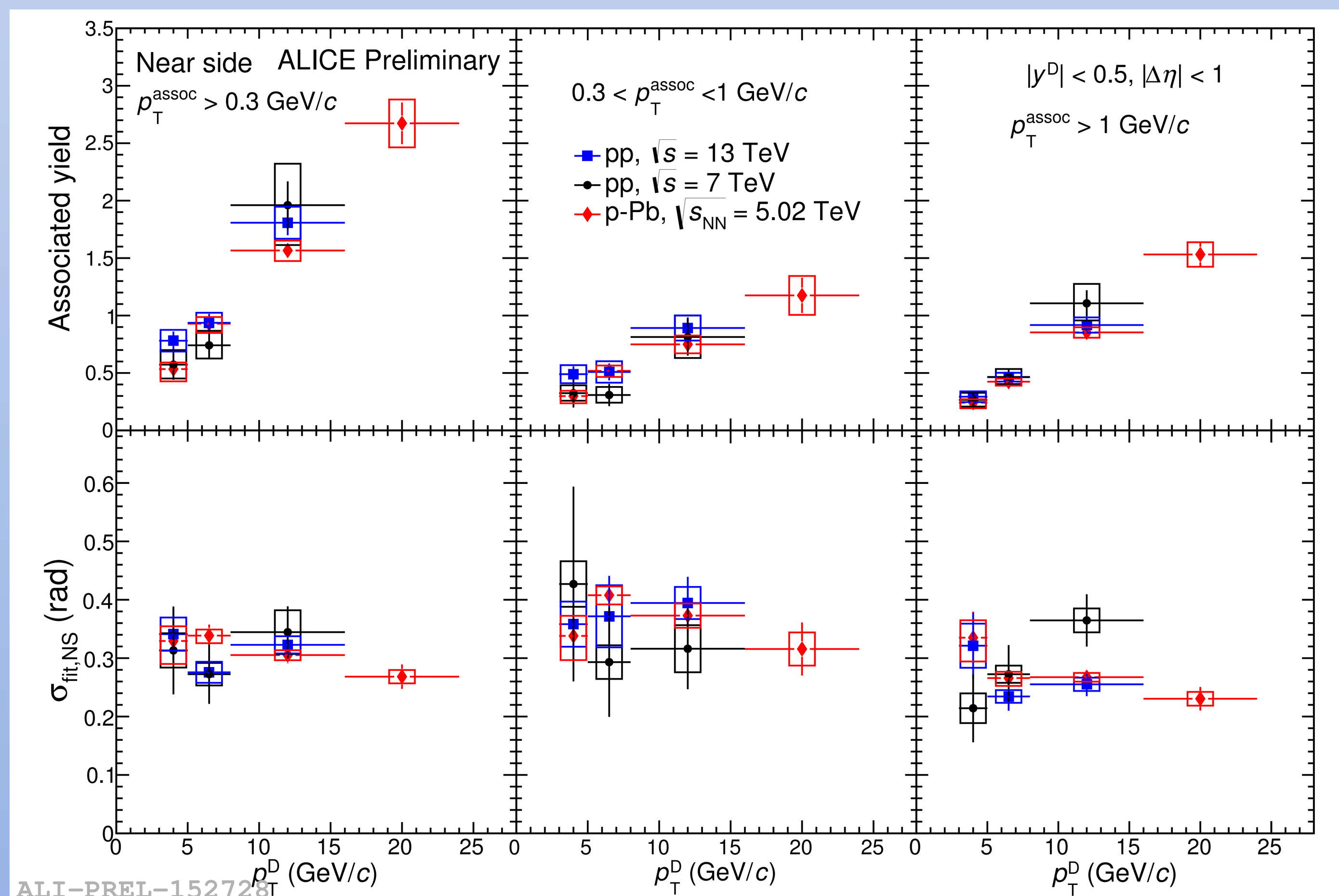
- The comparison of results is performed after baseline subtraction.
- The shape of the correlation distributions and the evolution of correlation peaks are well reproduced by the generators for all the kinematic ranges.
- In the near side the data is well reproduced by models. In the away side POWHEG+PYTHIA6 and PYTHIA8 are closer to the data.




### Comparison of near-side peak yields and widths in pp and p-Pb collisions

pp, $\sqrt{s}$ = 13 TeV
pp, $\sqrt{s}$ = 7 TeV
p-Pb, $\sqrt{s_{NN}}$ = 5.02 TeV

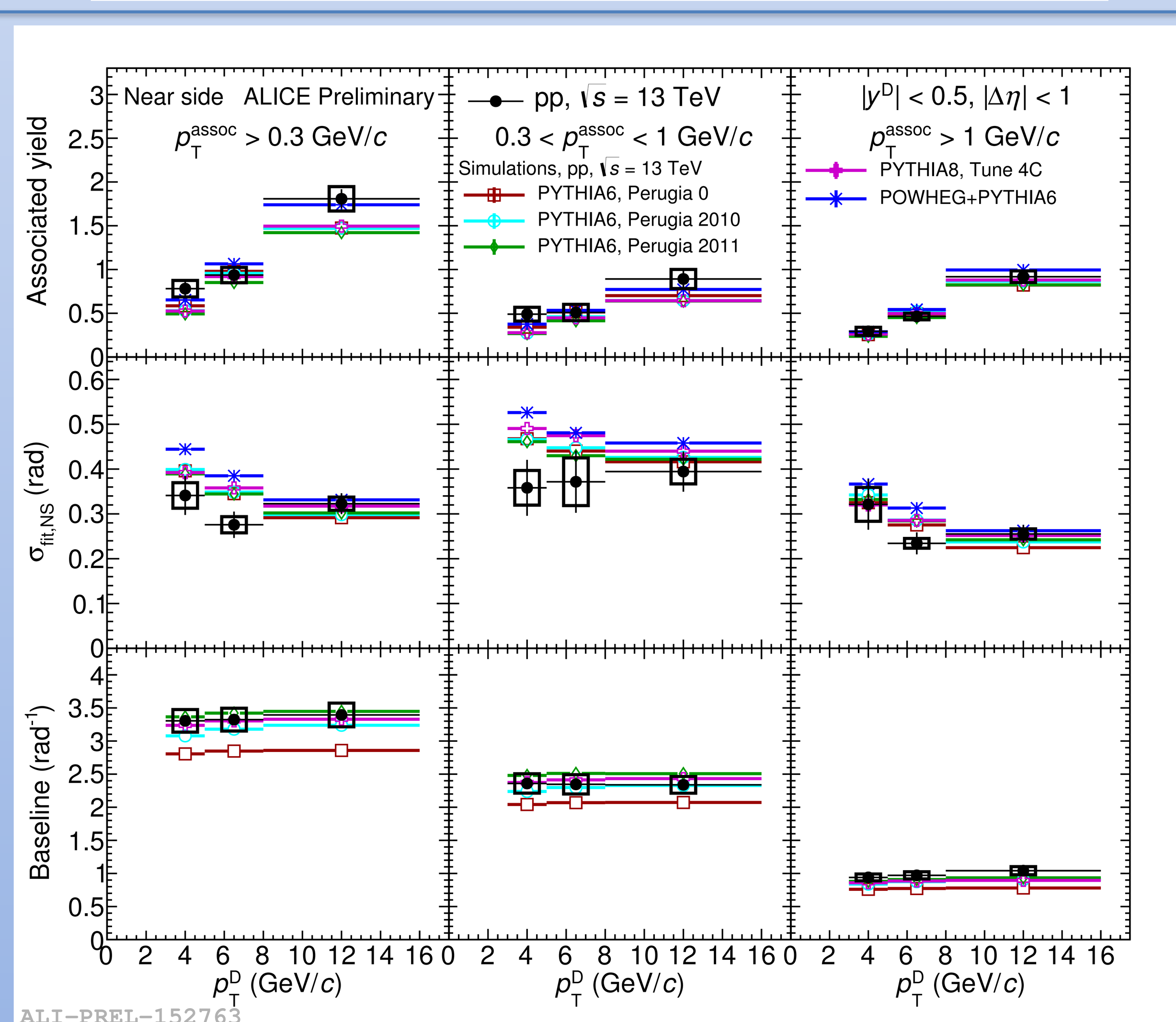
- Near-side yields and widths are extracted from the fit to the average correlation distributions.
- Compatible values and $p_T$ evolution of the near-side peak yield and width are found within uncertainties for all the kinematic ranges.




### Comparison of near-side peak yields, widths and baseline with Monte Carlo predictions

pp $\sqrt{s}$ = 13 TeV
Comparison with:
PYTHIA6 tunes Perugia 0, Perugia 2010, Perugia 2011
PYTHIA8
POWHEG+PYTHIA6 [4,5]

- Overall compatibility of near-side yields with MC predictions.
- Good description of near-side width within the uncertainties.




## Summary and outlook

- The baseline-subtracted azimuthal correlation distributions measured in pp collisions at $\sqrt{s}$ = 7 TeV, 13 TeV and p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV are compatible within uncertainties.
- The near-side peak yields and widths are also compatible for all energies and collision systems within uncertainties.
- The measured azimuthal distributions, as well as the properties of the correlation peaks, are qualitatively reproduced by PYTHIA and POWHEG+PYTHIA event generators.
- The addition of one more D-meson ($D^+$) and more statistics from 2017 data samples will increase the precision of the measurement for pp collisions at $\sqrt{s}$ = 13 TeV.

## References


[1] Yu.L. Dokshitzer, D.E. Kharzeev, Physics Letters B 519 (2001) 199-206.

[2] R. Baier, Y. L. Dokshitzer, A. H. Mueller, S. Peigne, and D. Schiff, Nucl. Phys. B 484, (1997) 265.

[3] B. Abelev et al. (ALICE Collaboration), JHEP 01 (2012) 128 .

[4] P. Z. Skands, "Tuning Monte Carlo Generators: The Perugia Tunes", Phys. Rev. D82 (2010) 074018.

[5] T. Sjostrand, S. Mrenna, and P. Z. Skands, "A Brief Introduction to PYTHIA 8.1", Comput. Phys. Commun. 178 (2008) 852867.